(12) UK Patent Application (19) GB (11) 2 179 008 A

(43) Application published 25 Feb 1987

(21) Application No 8619196

(22) Date of filing 6 Aug 1986

(30) Priority data

(31) 762990 (32) 6 Aug 1985 (33) US

(51) INT CL[4]
B41J 5/00 G07B 17/04

(52) Domestic classification (Edition I):
B6F 201 203 239 262 AD AP

(56) Documents cited
EP 0022397 US 4488828

(58) Field of search
B6F

(71) Applicant
Pitney Bowes Inc.,

(Incorporated in USA-Connecticut),

One Elmcroft, Stamford, Connecticut 06926-0790, United States of America

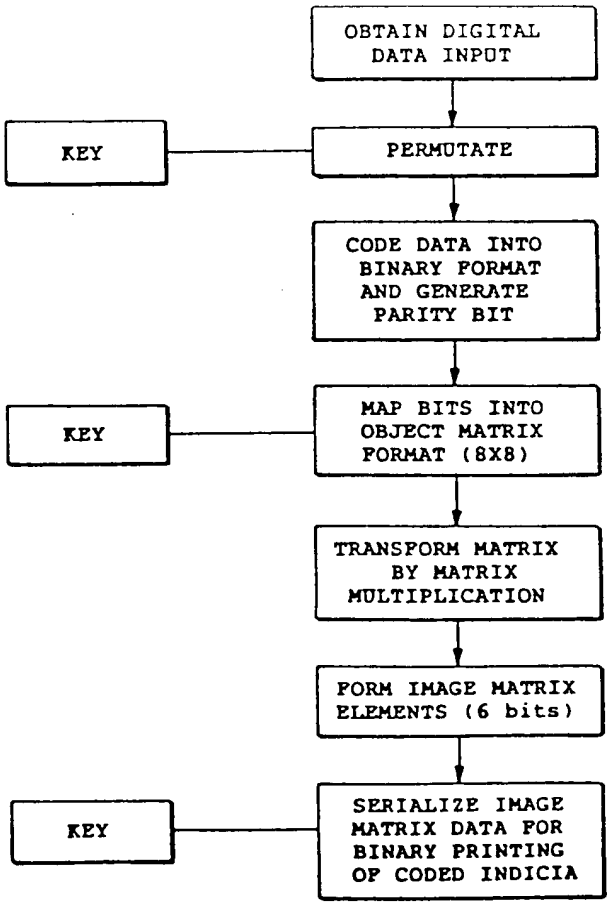
(72) Inventor
Jose Pastor

(74) Agent and/or Address for Service
D. Young & Co., 10 Staple Inn, London WC1V 7RD

(54) Postage meter with coded graphic information in the indicia

(57) In a postage meter using a dot matrix printer, a security code (peculiar to the particular machine) is defined by a dot matrix which, if printed, would be easily legible as characters; the thus defined matrix is transformed to a different matrix by encoding means; and the transformed matrix is printed as a (preferably unintelligable) matrix of dots (or the like). Thus the identity of an issuing machine can be determined, but only by a reverse transformation of the printed matrix.

FIG. 2



GB 2 179 008 A

The drawing(s) originally filed was (were) informal and the print here reproduced is taken from a later filed formal copy

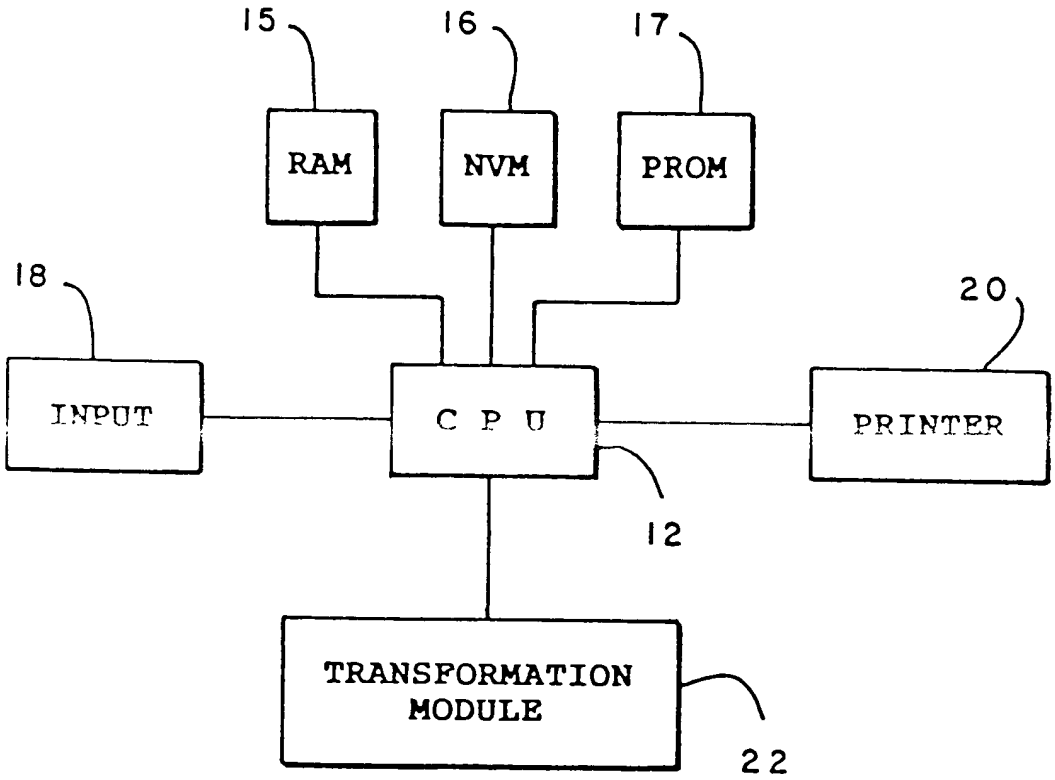
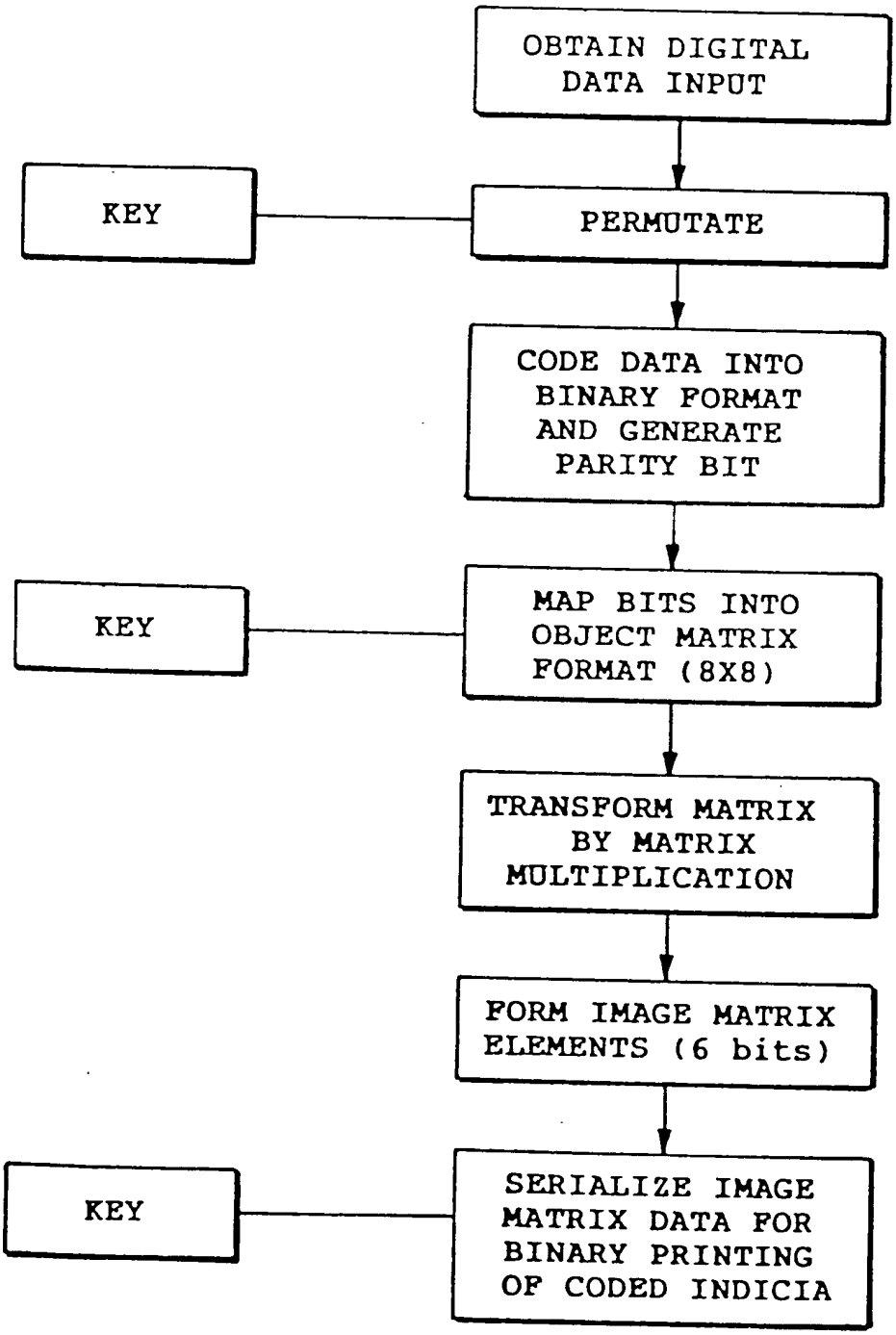

15
16
17
RAM
NVM
PROM
18
20
INPUT
C P U
PRINTER
12
TRANSFORMATION
MODULE
22

FIG. 1

FIG. 2


OBTAIN DIGITAL DATA INPUT
KEY
PERMUTATE
CODE DATA INTO BINARY FORMAT AND GENERATE PARITY BIT
KEY
MAP BITS INTO OBJECT MATRIX FORMAT (8X8)
TRANSFORM MATRIX BY MATRIX MULTIPLICATION
FORM IMAGE MATRIX ELEMENTS (6 bits)
KEY
SERIALIZE IMAGE MATRIX DATA FOR BINARY PRINTING OF CODED INDICIA

01110000
01101011
00011100
00010110
11000011
00110111
01100101
10101000

FIG. 3A

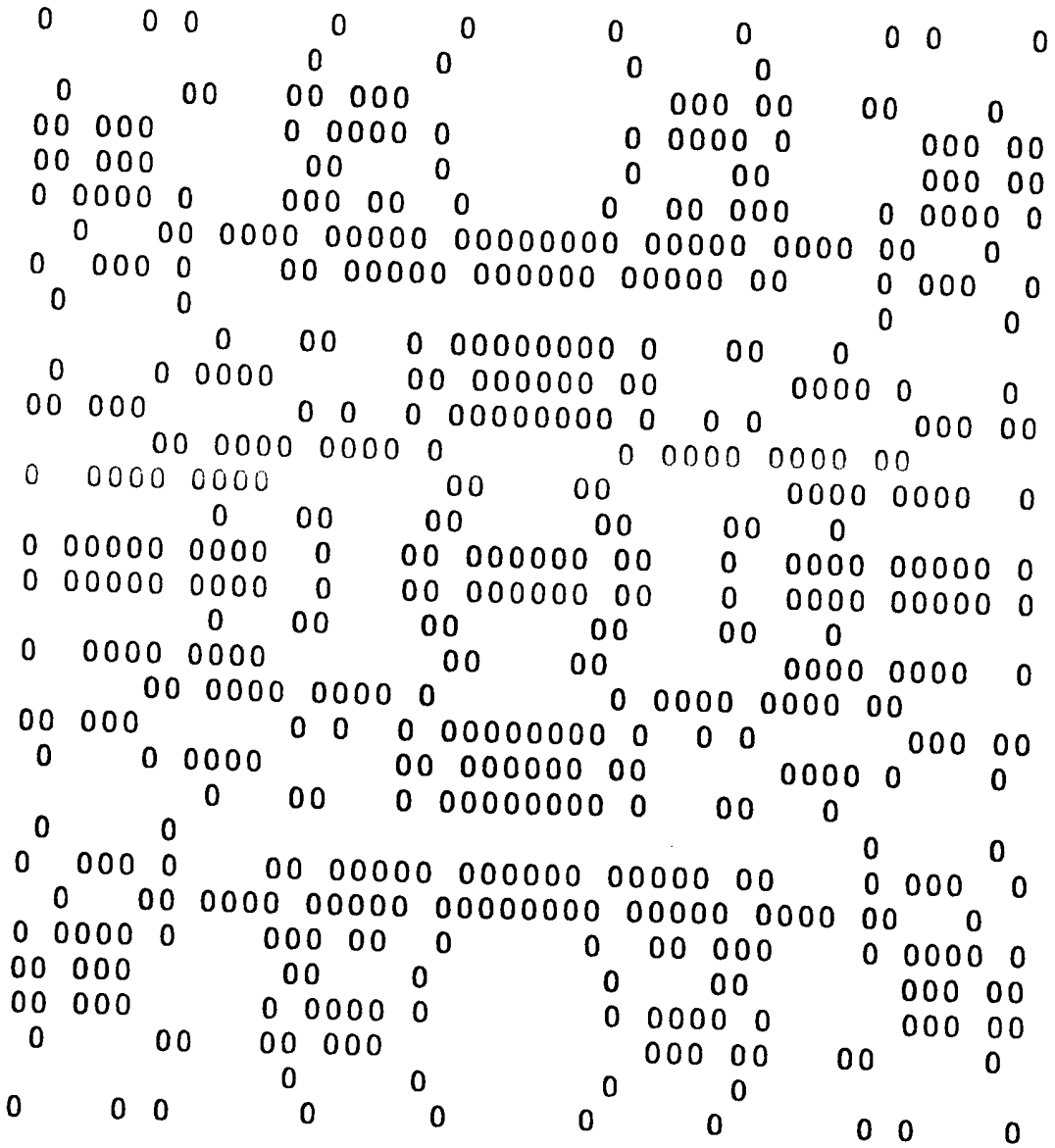
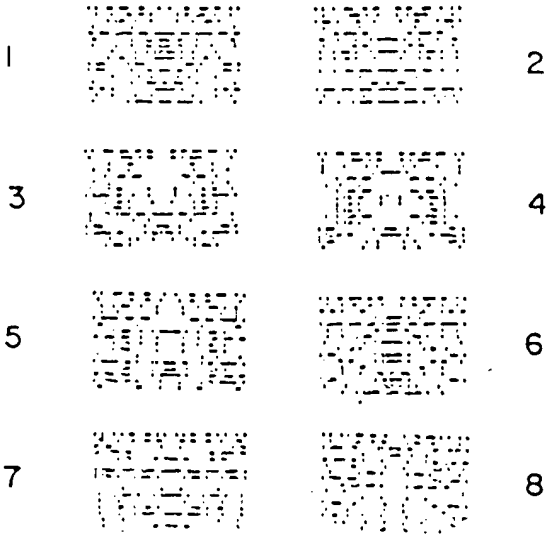


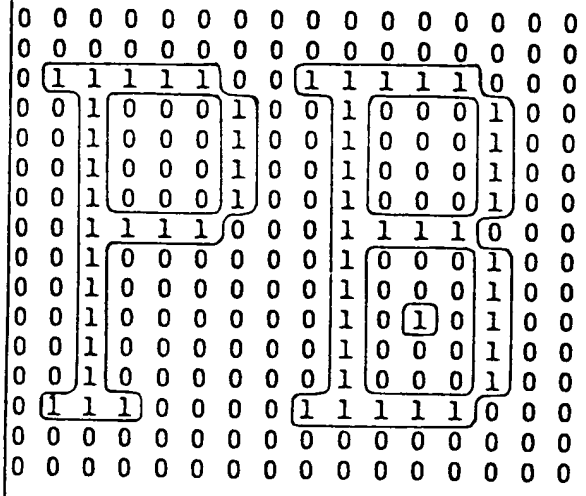
FIG. 3B

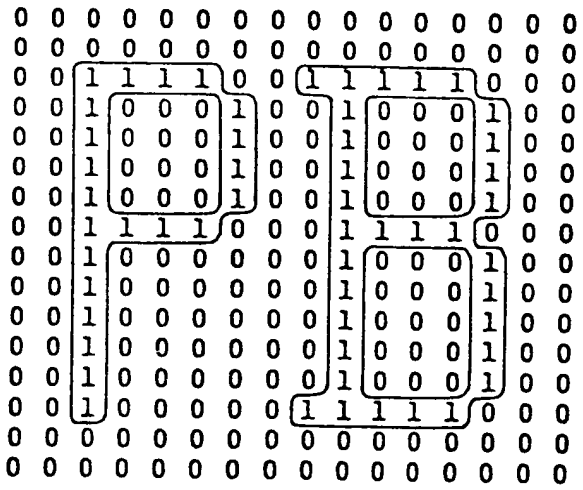
FIG. 4

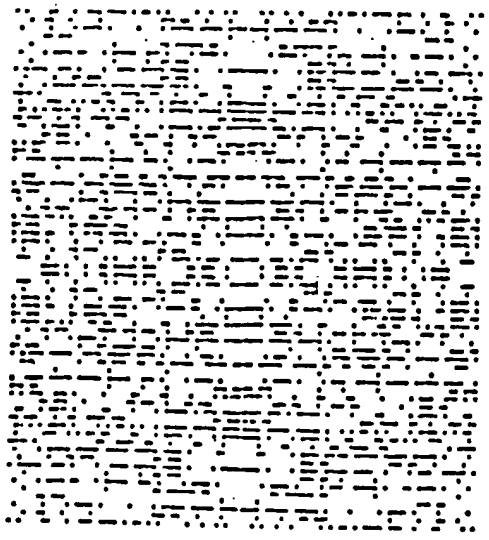


	NEXT INSPECTION DATE		TRANSACTION DATE		
	MONTH	DAY	MONTH	DAY	HOUR
1	NOV.	18	SEP.	25	20
2	NOV.	18	SEP.	24	19
3	NOV.	18	OCT.	24	19
4	NOV.	17	OCT.	24	19
5	DEC.	17	OCT.	24	20
6	NOV.	18	SEP.	25	19
7	JAN.	02	JAN.	01	01
8	DEC.	31	DEC.	31	18

FIG. 5







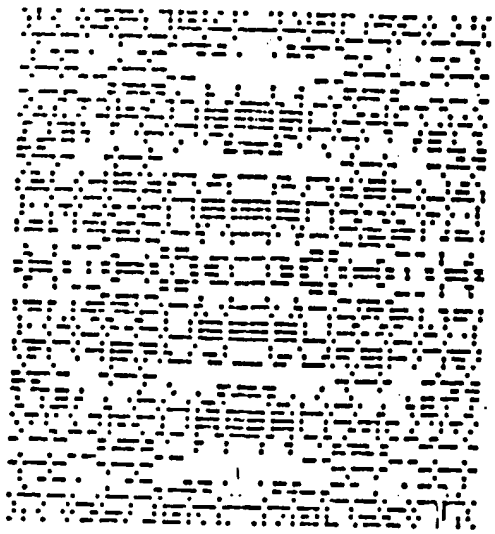
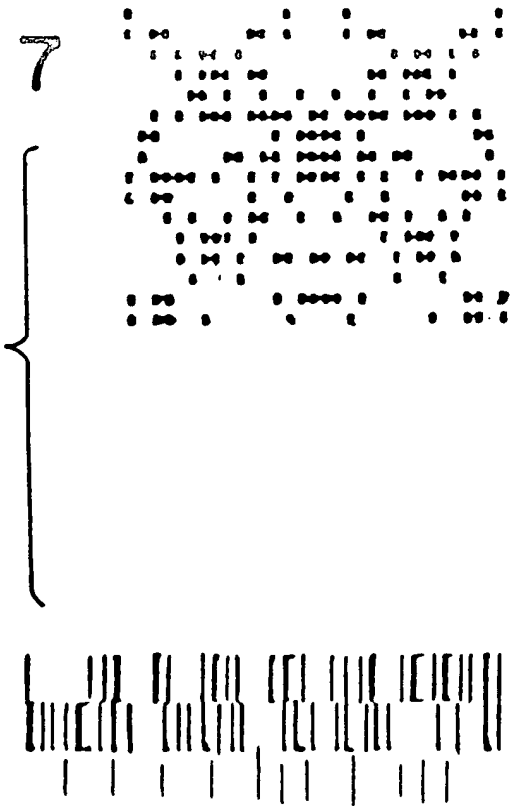


FIG. 6

```
P$$J$oo$$oo$Y$$o
$$$$$$$$$$$$$$$$
g$$A$BB$$BB$w$$R
$$$$$$$$$$$$$$$$
B$$B$ww$$ww$w$$w
$$$$$$$$$$$$$$$$
o$$o$oo$$oo$o$$o
$$$$$$$$$$$$$$$$
B$$B$ww$$ww$w$$w
$$$$$$$$$$$$$$$$
o$$o$oo$$oo$o$$o
$$$$$$$$$$$$$$$$
Y$$o$oo$$oo$J$$o
$$$$$$$$$$$$$$$$
w$$R$ww$$ww$B$$g
$$$$$$$$$$$$$$$$
```

FIG. 7



SPECIFICATION

Postage meter with coded graphic information in the indicia

The invention relates to electronic postage meters and metering systems and particularly to an improved method and apparatus for assuring the validity of a postal indicia printed by a postage metering system. The term electronic postage meter or metering system as used herein also refers to other similar meters, such as parcel registers and tax stamp meters which dispense and account for value.

Since the days of the first postage meter, security has been considered the heart of postage meter operation. Security must be absolute since monetary value is being printed.

In prior postage meters, an indicia is printed by a letter press utilizing a uniquely engraved die containing postal information, such that the metered postage indicia is traceable to a particular postage meter. Newer postage meters have been developed which include electronically controlled printers, such as thermal printers, ink jet or dot matrix pin printers for printing the indicia. While these newer meters work well in concept, there is a further consideration of security which must be addressed. Such indicias are rather easily printed by anyone who has a computer operating under a suitable program and an appropriate printer. One way of assuring the validity of a particular indicia has been to encode a message in the indicia such that an unauthorized person cannot reproduce the appropriate encoding.

Such meters utilizing encoded information are disclosed, for example, in our copending UK Patent Application Nos. 8609189 and 8609030.

In a system disclosed in our published European Patent Application Nos. 0 132 782 and 0 131 964 there is taught another method and apparatus for producing a coded indicia. In this device, the encoding is such that the indicia is printed in human readable format, but the dots forming the indicia are modified by voids or displacements or the like in order to produce a coded message which is then decodable to ensure that the coded information is identical to the human readable information of the indicia.

In one aspect of this invention there is provided apparatus for metering value comprising apparatus for assuring the validity of printed information which includes:

(a) means for defining a plurality of selected dot-locations in a first array in which if dots were printed at said dot-locations the first array would provide information in a conventional readable format;

(b) transformation means for converting the first array of said dot-locations into a second array of a selected plurality of dot-locations, said second array being different from said first array in a predetermined manner wherein said first array is recoverable from said second array;

(c) printing means for printing dots in response to print signals; and

(d) printer communication means for communicating print signals from said transformation means to said printing means, said print signals being indicative of the dot-locations of said second array whereby said printing means is operative to print an array of selected dots in accordance with said second array of dot-locations.

Preferably, said second array is not in a conventional readable format.

Preferably said defined dot-locations in said first array represent binary coded data.

Advantageously the information includes data known only to the meter manufacturer.

In another aspect of this invention there is provided apparatus for metering value which includes a dot printer, a transformation means operative to encode information for security purposes, said transformation means including matrix multiplication means for transforming in a predetermined manner dot-location signals indicative of information in a first binary matrix into dot-location signals indicative of a second binary matrix, and wherein print signals derived from said dot-location signals indicative of said second binary matrix are fed to the dot printer for printing of dots in correspondence therewith such that the information in the first binary matrix is available by a reverse transformation applied to the matrix of dots printed in the second binary matrix.

Preferably said second binary matrix is not a conventional readable format.

Preferably said first binary matrix is a square matrix of size 2N by 2N where N is a counting number; the first binary matrix may be of size 8 by 8.

In another aspect of this invention there is provided a method for providing a validating indicia for the metering of a selected value comprising the steps of:

(a) providing digital information to be encrypted;

(b) defining a first binary matrix of dot-locations containing the digital information in a predetermined binary format;

(c) transforming the first array of said dot-locations into a second matrix of a plurality of dot-locations by a matrix multiplication of said first binary matrix by a third matrix, and generating print signals in accordance with the dot-locations of the second matrix thereof;

(d) printing dots in selected locations in correspondence with the print signals indicative of the dot-locations of said second matrix; and

(e) accounting for the printing of the selected value.

Preferably a portion of the dots are printed in a colour different from that of the remainder of the dots.

This method preferably further comprises the step of scrambling the bits of said second binary matrix prior to printing the dots in step (d).

The method conveniently further comprises the steps of:

(a) reading the selected printed dots to define the corresponding image matrix;

(b) performing an inverse transformation to obtain said first binary matrix whereby the information in said first binary matrix may be read.

In this method the digital information preferably includes information known only to the meter manufacturer.

In another aspect of this invention there is provided a method for encrypting an indicia comprising the steps of:

(a) defining a first binary matrix of the data to be

encrypted;

(b) multiplying the first binary matrix by another matrix for transforming said first matrix into a second matrix having elements in binary form; and

(c) printing dots in accordance with said second matrix elements.

In this method the elements of said second matrix may be printed as a bar code, or as alphanumerics, or as a serial string of alphanumeric data.

In another aspect of this invention there is provided apparatus for metering value comprising:

(a) digital input means for receiving information and a value to be metered;

(b) means for defining a selected plurality of dot-locations in a first array wherein dots printed at the dot-locations in the first array encode said information in a predetermined binary format;

(c) transformation means for converting the first array of said dot-locations into a second array of a selected plurality of dot-locations, said second array being derived from said first array through a predetermined matrix multiplication;

(d) printing means for printing dots in response to print signals;

(e) printer communication means for communicating print signals from said conversion means to said printing means, said print sigals being indicative of the dot-locations of said second array whereby said printing means is operative to print an array of selected dots in accordance with said second array of selected dot-locations; and

(f) accounting means operative to account for the printing of the selected value when said array of selected dots is printed by said printing means.

Further features and advantages of the method and apparatus in accordance with the invention will become apparent from the following description which is by way of example only, reference being made to the accompanying drawings in which:-

Figure 1 shows a block diagram of a system which is adapted to print an indicia in accordance with the instant invention.

Figure 2 shows a flow chart for performing a transformation in accordance with the invention.

Figure 3A and *3B* show a transformation illustrating the creation of a particular image matrix wherein the 0's of the printed array represent the dots of the image array in accordance with the invention.

Figure 4 is an illustration of various printed matrices showing the trasformation of encrypted date information in accordance with the invention.

Figure 5 is an illustration of the matrix transformation of graphic data.

Figure 6 is an illustration of another indicia wherein the image matrix elements are printed as an alpha numeric array.

Figure 7 is an illustration of the printing of the transformed image matrix as a serialised bar code.

Referring in general to the following diclosure, it has been found that with the use of known electronic binary dot matrix printing means, such as ink jet, thermal head, LED printer and the like, one can introduce a greater flexibility into the printed indicia than hitherto considered possible and thereby one can further encrypt for even greater security any desired variables including postal value, and particularly those variables, e.g., the next inspection date, that would be known only to the meter manufacturer or in a data centre, in order to validate the postal transaction. The encrypted variable or variables can be printed in addition to the conventional indicia or substituted therefor.

In accordance with the system described, the information to be printed is first described in a binary format or pixels or dot-positions in a matrix, preferably a square matrix of 2N by 2N configuration, where N is a counting number, referred to herein as the object matrix (OB). The pixels of the object matrix (OB) may incorporate binary coded information in some predetermined order or may constitute one or more alphanumeric or other character or characters in graphic form.

An image transformation is then applied to this matrix, preferably by matrix multiplication by another 2N by 2N matrix "A", such that the transformation is of the form (IM) = (A)(OB)(A) wherein (IM) is the transformed image matrix. The pixels or dots of the image resulting matrix (IM) are then printed. It will be understood that if further security is desired the binary bits or pixels of the resulting image (IM) may again be scrambled in predetermined manner.

It will be appreciated that the redundancy of information can be increased by printing a number of similar matrices having the same image pattern and in symmetric or non-symmetric format. When the image matrix is printed in first format and then as a reflection of the first format, the probability of losing information is reduced if the printed data is deflective because of a printer element failure. It will be understood that while larger matrices are contemplated and will accomodate larger blocks of information, the use of smaller square matrices, e.g. 8 by 8 matrices, is preferable.

Referring now to Figure 1, there is shown at 10 a postage metering system in accordance with present invention. At the heart of this system is the CPU or microprocessor 12, which operating under the specific instructions from a program residing in PROM 14, controls the basic meter functions, performs calculations based on any input data, and controls the flow of data into the various memories. Typically, a Ram 15 is connected to the CPU for the storage of real time information and for the real time accounting of critical accounting information including updating of ascending and descending meter registers which values are then stored in more permanent form in nonvolatile memory 16 either when the power is interrupted or on a real time basis as is well known in the art.

The system operates in accordance with data, e.g. value to be metered, supplied from an appropriate input means, such as the input keyboard 18 or from a communication device such as described in U.K. Patent No. 2 062 312.

The CPU 12 is also coupled to a printer 20 which receives print signals from CPU 12 for the printing of postal information on an envelope, label or the like. The printer for use in accordance with the invention conventional may be a conventional dot-matrix pin printer, or any one of the plurality of like type devices, such as ink jet printers, thermal printers, or LED printers, which are suitable for receiving electronic

signals and converting these into dots or pixels printed on a document.

As seen in Figure 1, CPU 12 is also coupled to a transformation module 22 which operates in accordance with the invention to transform information in an initial object format into an encrypted image format which will include information to assure validity of the indicia.

Figure 2 is a flow chart showing the functions performed in the transformation module 22. It will be understood that the operations may be performed by a microcomputer resident in the transformation module 22 which then communicates in known manner with the CPU 12 or by means of a program stored in PROM 14 accessed in conventional manner by the CPU 12.

Digital data is received from the keyboard 18 or graphic and other digital data may be generated by CPU 12 as an array of pixels for providing graphic information, which data in binary form would typically be fed to the printer 20 as electronic signals for printing a desired image. In accordance with the invention the data is fed to the transformation module 22 and is stored in, for instance, a suitable buffer, as a plurality of binary bits representing the alphanumeric or graphic data from which it is derived.

The stored data is then read from the buffer into other registers in a format suitable for forming an 8 by 8 binary matrix, the object matrix (OB). The data may be permutated in any predetermined manner prior to being read into the matrix format and additionally may be incorporated in the binary matrix in any predetermined manner in accordance with specified keys. Thus, a given serialized stream of data may be presented as rows or columns of data, forwards or backwards, or as a spiral-like string beginning on the sides or near the center, or as predetermined random distributions within the matrix. These descriptions are presented by way of example only and should not be considered as limiting the invention. For best results the binary matrix array has a parity bit so as to make the number of bits always an even or odd number or to identify and/or select the parity for proper processing.

It will be appreciated that an operator or inspector at this point, knowing the keys, will be easily able to retrieve the data from the array of dots in the matrix were it to be printed or displayed. It must be noted that the digital data forming the matrix (OB) may also be the binary representation of an encrypted string of alpha numeric data generated as described, for example, in copending U.K. Patent Application No. 09189, which would then require even further decryption to obtain the originally encrypted information.

In accordance with the invention, a matrix transformation is applied to the above defined object matrix. A suitable and convenient transformation is a matrix multiplication of the form (IM) = (A)(OB)(A) where (A) is a matrix multiplier of the same size as (OB), in this case 8 by 8, wherein the determinant of (A) is not equal to zero, and (IM) is the resultant transformed matrix product.

The elements of the multiplier matrix (A) may conveniently be both positive and negative as well as zero. For best results, there is a further constraint that each of the resulting elements of the image matrix be numbers represented by a maximum of six bits for the 8 by 8 matrix illustrated. With the proper selection of the matrix "A" all the elements of the image matrix (IM) are positive or negative numbers with the same parity as matrix (OB). Negative numbers in this format may then be represented by their selected matrix (OB) parity complement. Alternatively of course the negative may be represented by a sign bit, the disadvantage being the extra printing element that would be required to produce the dot.

It will be understood that larger matrices will allow the encryption of even larger amounts of data, however, at the expense of the need for much greater data manipulation. A plurality of different 8 by 8 matrices may of course be generated and printed on a document if desired. It will also be appreciated by those skilled in the art that while square matrices having an odd number of rows and columns may be utilized, the recovery of the original object matrix data in such case is considerably harder since the image matrix elements do not necessarily always fall within the aforementioned contraints as to size.

The matrix multiplication detailed above may be accomplished by the microprocessor or CPU 12 operating under a suitable program or alternatively may be conveniently carried out in a matrix multiplier LSI chip manufactured and marketed by INTEL, Santa Clara, California, suitably connected to receive the data pixels of the matrix (OB) and to communicate the matrix product (IM) to a buffer in the transformation module 22 or to the RAM 14 for communication to the printer 20.

It will be understood that the bits resulting from the matrix transformation may again be scrambled in accordance with a predetermined key if desired in order to further enhance the security of the encryption.

Preferably the image matrix is printed at least twice using a two-fold symmetry and for best results is printed four times with a four-fold symmetry, i.e. as a mirror reflection of itself and then another reflection of the two images thus produced. The advantage of providing this redundancy, besides the aesthetic qualities, thus produced, is that any the probability of losing information due to any inoperative printing element of the printer 20 may be reduced. It will be appreciated that the image matrix formed as described above may be printed in contiguous or non-contiguous formats, as borders for other printed matter, and as a supplement to or in place of other indicia on a mailpiece or document. If the printer is capable of printing in several colors a predetermined pattern of bits in the object matrix may be transformed and printed as a different plurality of dots in the image colored differently from the remainder of the printed dots. The resulting image pattern of colors might thus be more easily recognized as a valid indicia by a trained inspector simply by visual inspection of the printed matrix.

As mentioned previously the elements of the image matrix are numbers and as such may be represented in ways other than as the binary image matrix described in conjunction with Figure 2. Thus the image matrix elements may be printed as a matrix array of alphanumeric characters if desired or may be printed serially as a bar code.

Figure 3A and 3B show an obje. matrix (OB) consisting of an array of binary data (shown in Figure 3A) and a representation of the corresponding image matrix (IM) resulting from a transformation in accordance with the invention. The object matrix (OB) shown in Figure 3A is multiplied by the known "HADAMARD" matrix to obtain the image matrix shown in Figure 3B. The 0's shown in the image matrix represent the actuated pixels of the printer. As previously described, the image matrix (IM) in Figure 3B is printed in four-fold symmetry; the matrix (IM) of the upper right-hand corner being reflected into the left-hand corner and both being reflected into the left-hand corner and both being reflected into the lower half of the array as illustrated in Figure 3B.

Figure 4 shows various printed matrices in accordance with the invention in a sequence with the having data encrypted in the matrix being listed below the matrices. As illustrated, the data to be encrypted includes the date of the next inspection, a number which may be kept as a secret by the manufacturer or meter inspector and the transaction date. The encryption of data relating to the device incorporating the invention herein adds another level of security to that offered by the graphic encoding provided for validating and assuring the authenticity of the transaction.

Figure 5 is an illustration of the matrix transformation of graphic data, which in this example is incorporated in a 16 by 16 matrix. The character being encoded are a graphic "P" and "B". It will be appreciated that in comprising the image matrices a very minute change in the pixels forming the object matrix can result in significant changes in the image matrix.

Figure 6 is an illustration of an image matrix in which the elements which have been transformed in accordance with the invention are printed as an array of alphanumeric characters. It will be understood that the characters of the matrix array may be serialized and printed as a data string.

Figure 7 is an illustration of the printing of the data generated by a transformation in accordance with the invention in the form of a serialized bar code.

The information included in the object matrix in any of the illustrated formats is made available to an inspector by performing a reverse transformation algorithm of the dots encrypted in the image matrix.

CLAIMS

1. Apparatus for metering value comprising apparatus for assuring the validity of printed information which includes:

(a) means for defining a plurality of selected dot-locations in a first array in which if dots were printed at said dot-locations the first array would provide information in a conventional readable format;

(b) transformation means for converting the first array of said dot-locations into a second array of a selected plurality of dot-locations, said second array being different from said first array in a predetermined manner wherein said first array is recoverable from said second array;

(c) printing means for printing dots in response to print signals; and

(d) printer communication means for communicating print signals from said transformation means to said printing means, said print signals being indicative of the dot-locations of said second array whereby said printing means is operative to print an array of selected dots in accordance with said second array of dot-locations.

2. Apparatus according to claim 1 wherein said second array is not in a conventional readable format.

3. Apparatus according to claim 1 or claim 2 wherein said defined dot-locations in said first array represent binary coded data.

4. Apparatus according to any of the preceding claims wherein the information includes data know only to the meter manufacturer.

5. Apparatus for metering value which includes a dot printer, a transformation means operative to encode information for security purposes, said transformation means including matrix multiplication means for transforming in a predetermined manner dot-location signals indicative of information in a first binary matrix into dot-location signals indicative of a second binary matrix, and wherein print signals dereved from said dot-location signals indicative of said second binary matrix are fed to the dot printer for printing of dots in correspondence therewith such that the information in the first binary matrix is available by a reverse transformation applied to the matrix of dots printed in the second binary matrix.

6. Apparatus according to claim 5 wherein said second binary matrix is not in a conventional readable format.

7. Apparatus according to claim 5 or claim 6 wherein the first binary matrix is a square matrix of size 2N by 2N where N is a counting number.

8. Apparatus according to claim 7 wherein the first binary matrix is of size 8 by 8.

9. A method for providing a validating indicia for the metering of a selected value comprising the steps of:

(a) providing digital information to be encrypted;

(b) defining a first binary matrix of dot-locations containing the digital information in predetermined binary format;

(c) transforming the first array of said dot-locations into a second matrix of a plurality of dot-locations by a matrix multiplication of said first binary matrix by a third matrix, and generating print signals in accordance with the dot-locations of the second matrix thereof;

(d) printing dots in selected locations in correspondence with the print signals indicative of the dot-locations of said second matrix; and

(e) accounting for the printing of the selected value.

10. A method according to claim 9 wherein a portion of the dots are printed in a colour different from that of the remainder of the dots.

11. A method according to claim 9 or claim 10 and further comprising the step of scrambling the bits of said second binary matrix prior to printing the dots in step (d).

12. A method according to any of claims 9 to 11 and further comprising the steps of:

(a) reading the selected printed dots to define the corresponding image matrix;

(b) performing an inverse transformation to obtain

said first binary matrix whereby the information in said first binary matrix may be read.

13. A method according to any of claims 9 to 12 wherein the digital information includes information known only to the meter manufacturer.

14. A method for encrypting an indicia comprising the steps of:

(a) defining a first binary matrix of the data to be encrypted;

(b) multiplying the first binary matrix by another matrix for transforming said first matrix into a second matrix having elements in binary form; and

(c) printing dots in accordance with said second matrix elements.

15. A method according to claim 14 wherein the elements of said second matrix are printed as a bar code.

16. A method according to claim 14 wherein the elements of the second matrix are printed as alphanumerics.

17. A method according to claim 16 wherein the elements are printed as a serial string of alphanumeric data.

18. Apparatus for metering value comprising:

(a) digital input means for receiving information and a value to be metered;

(b) means for defining a selected plurality of dot-locations in a first array wherein dots printed at the dot-locations in the first array encode said information in a predetermined binary format;

(c) transformation means for converting the first array of said dot-locations into a second array of a selected plurality of dot-locations, said second array being derived from said first array through a predetermined matrix multiplication;

(d) printing means for printing dots in response to print signals;

(e) printer communication means for communicating print signals from said conversion means to said printing means, said print signals being indicative of the dot-locations of said second array whereby said printing means is operative to print an array of selected dots in accordance with said second array of selected dot-locations; and

(f) accounting means operative to account for the printing of the selected value when said array of selected dots is printed by said printing means.

19. Apparatus for metering value substantially as hereinbefore described with reference to and as illustrated in any of the accompanying drawings.

20. A method for providing a validity indicia substantially as hereinbefore described with reference to and as illustrated in any of the accompanying drawings.

21. A method for encrypting an indicia substantially as hereinbefore described with reference to and as illustrated in any of the accompanying drawings.

22. Any and all novel features of the embodiments described or illustrated herein.

Printed for Her Majesty's Stationery Office by
Croydon Printing Company (UK) Ltd. 12/86. D8817356
Published by The Patent Office, 25 Southampton Buildings London, WC2A 1AY,
from which copies may be obtained